DOCUMENT RESUME

ED 080 662 VT 020 373

AUTHOR Farning, Maxwell
TITLE Career Education: The Marine Science Occupations Cluster.
INSTITUTION Ohio State Univ., Columbus. Center for Vocational and Technical Education.
SPONS AGENCY National Inst. of Education (DHEW), Washington, D.C.
REPORT NO Inf-Ser-85
PUB DATE 73
NOTE 21p.
AVAILABLE FROM Product Utilization Section, The Center for Vocational and Technical Education, 1960 Kenny Road, Columbus, OH 43210 (One of a set, prices available upon request)

EDRS PRICE MF-$0.65 HC-$3.29
DESCRIPTORS Career Education; *Career Opportunities; Construction (Process); Educational Needs; Fisheries; Fuels; Marine Biology; *Marine Technicians; *Occupational Clusters; Occupational Information; *Ocean Engineering; Oceanology; *Seamen; Water Resources

ABSTRACT

This paper discusses career opportunities in eight broad groups of marine science occupations: (1) harbor construction and maintenance, (2) ship construction, (3) merchant marine activities, (4) towboating, (5) longshoring, (6) fishing and fish farming, (7) petroleum and natural gas exploration and extraction, and (8) research activities. The marine science cluster is defined to include those occupations which are directly related to activities occurring because of the presence of large bodies of water. Each of the groups described contains occupations with education and training requirements ranging from those calling for very limited skills to those requiring doctoral degrees. An annotated bibliography provides additional sources of information for marine science occupations. (MF)

FILMED FROM BEST AVAILABLE COPY

Information Series
No. 85
VT 020 373

CAREER EDUCATION: THE MARINE SCIENCE OCCUPATIONS CLUSTER

ERIC

CLEARINGHOUSE ON VOCATIONAL AND TECHNICAL EDUCATION

VT020373

FILMED FROM BEST AVAILABLE COPY

ACKNOWLEDGEMENTS

The profession is indebted to Maxwell Farning for his scholarship in the preparation of this report. Recognition is also due Paul Tolonen, Mount Hood Community College, for his critical review of the manuscript prior to final revision and publication. The development of the publication was coordinated by Paul E. Schroeder, and Paula K. Young provided the technical editing.

Robert E. Taylor
Director
ERIC Clearinghouse on Vocational
and Technical Education

The material in this publication was prepared pursuant to a contract with the National Institute of Education, U.S. Department of Health, Education, and Welfare. Contractors undertaking such projects under government sponsorship are encouraged to express freely their judgment in professional and technical matters. Points of view or opinions do not, therefore, necessarily represent official National Institute of Education position or policy.

ED 080662

U S DEPARTMENT OF HEALTH,
EDUCATION & WELFARE
NATIONAL INSTITUTE OF
EDUCATION
THIS DOCUMENT HAS BEEN REPRODUCED EXACTLY AS RECEIVED FROM THE PERSON OR ORGANIZATION ORIGINATING IT. POINTS OF VIEW OR OPINIONS STATED DO NOT NECESSARILY REPRESENT OFFICIAL NATIONAL INSTITUTE OF EDUCATION POSITION OR POLICY

Information Series No. 85
VT 020 373

CAREER EDUCATION:

THE MARINE SCIENCE OCCUPATIONS CLUSTER

Maxwell Farning
Assistant Professor
Industrial Teacher Education
University of Wisconsin
Menominee, Wisconsin

ERIC Clearinghouse on Vocational and Technical Education
The Center for Vocational and Technical Education
The Ohio State University
1960 Kenny Road Columbus, Ohio 43210

1973

CONTENTS

Introduction 1
Harbor Construction and Maintenance 2
Ship Construction 3
Merchant Marine Activities 4
Tugboating 6
Longshoring 7
Fishing and Fish Farming 8
Petroleum and Natural Gas Exploration and Extraction 9
Research 10
Sources of Additional Information 11
Summary 11
Annotated Bibliography 13

INTRODUCTION

By definition, the marine science cluster includes those occupations directly related to activities that occur because large bodies of water are present. These large bodies of water include the oceans, seas, gulfs, lakes, and rivers. For the individual living in the United States, most of the marine science occupations are near the Atlantic and Pacific Oceans, the Gulf of Mexico, the Great Lakes, Puget Sound, and major rivers such as the Mississippi and the Columbia.

Although most people think of water transportation and fishing when speaking of marine science, these two areas are only a part of the total marine science cluster. While occupations within the marine science cluster can be classified many different ways, one way is to group them according to economic and social purpose. The following eight classifications were developed: (a) harbor construction and maintenance, (b) ship construction, (c) merchant marine activities, (d) tugboating, (e) longshoring, (f) fishing and fish farming, (g) petroleum and natural gas exploration and extraction, and (h) research. Education and/or training for jobs within each of these eight classifications range from minimal to extensive.

Another means of grouping these occupations would be to classify them according to education and training requirements. This method assumes that the individual searching for a career first determines the level of education and training that he aspires to and then selects an occupational goal that fits these educational aspirations. An assumption that seems more valid is that the student tends to investigate an occupation and during his investigation discovers the educational/training requirements. This paper assumes that the student makes a tentative career choice based on: (1) his potential enjoyment of the work, and (2) the amount and type of educational and training requirements of the work. Final career choices are made as additional career information is acquired. This paper discusses career opportunities within the eight broad areas of:

a) harbor construction and maintenance,

b) ship construction,

c) merchant marine activities,

d) tugboating,

e) longshoring,

f) fishing and fish farming,

g) petroleum and natural gas exploration and extraction, and

h) research.

HARBOR CONSTRUCTION AND MAINTENANCE

A harbor is a place that affords ships sufficient docking or anchorage in order that cargo and passengers can be loaded and unloaded. Several hundred years ago, harbors were selected in accordance with how nature had developed them. Those offering the most protection from the sea and wind were the most desirable. Today, man utilizes his technology to improve harbors so that passengers, cargo, and industrial fluids can be loaded and unloaded with maximum efficiency. The term "shipping port" includes such things as the harbor, ships, pier, passengers, cargo, and the activity that occurs at the waterfront when ships are being loaded and unloaded.

Among the first steps when developing a harbor is designing the pier and shoreline. Because the port is an economic activity, it must be constructed so that passengers and large volumes of cargo can be quickly and efficiently transferred between ship and shore. Often it is necessary to alter the shoreline and to dredge the bottom of the harbor to increase the efficiency of the shipping port.

The major aspect of designing a port is done by civil engineers. These civil engineers must have considerable knowledge of breakwaters, waves, tides, buoyancy, and soil mechanics. Also, mechanical and electrical engineers play a major role in the development and construction of a shipping port. Prior to any construction project, an extensive survey of the construction site must be completed. Civil engineers, together with survey technicians, survey the area. Part of this procedure involves gathering and testing the various soil samples. Much of this work is done outside, where temperatures can range from very warm, to mild, to very cold. During the actual construction period, the engineers again spend considerable amounts of time outside, ascertaining that construction is proceeding according to specifications. However, upon completion of the site survey and prior to the actual construction period, most of the designing efforts are accomplished indoors under clean, comfortable conditions.

Mechanical and electrical engineers also play a major part in the design effort. Today's shipping ports also require the expertise of electronics engineers since much of the necessary data is stored and retrieved electronically. Another engineering opportunity very worthy of investigation is oceanographic engineering. Because oceanographic engineers are usually employed in marine research activities, this career opportunity will be discussed under the heading "Research."

To become employed as an engineer, it is almost essential that the individual possess at least a bachelor's degree in engineering. It is also advantageous if the degree be earned in one

of the colleges or universities which places emphasis on marine engineering. Many of these colleges are located in states near the large bodies of water. The annual beginning salary in 1972 for engineers with a bachelor's degree was approximately $11,000. Engineers with 20 years of experience were earning an average of $17,000 to $20,000 annually.

Engineering aides (technicians usually having two years of post-high school technical education) who entered employment in 1972 often earned from $6,800 to $8,500 for their first year of employment. The technician can expect considerable increases in salary as he works and learns on the job. In 1972, technicians having 15 years of experience were often earning $10,000 to $13,000 per year.

In addition to the professional engineers and technicians required to design the port, many skilled and semiskilled tradesmen are needed during the construction of the port facilities. These tradesmen include carpenters, ironworkers, pipefitters, cement workers, electricians, sheet metal workers, pile drivers, dredging equipment operators, and general laborers. In fact, it would be difficult to find a construction trade that is not found in port construction. A carpenter who is specialized in pier construction is often called a dock builder or pile buck. To become a journeyman in these trades, the individual must first become an apprentice and work under the guidance of a journeyman for approximately five years.

Many of the journeymen tradesmen in 1972 were earning from $5.00 to $10.00 per hour. The hourly wage varied according to the location and size of the city and the trade speciality; usually the earnings were highest in the large northern cities. The student who is interested in pursuing a career in one of these areas should request additional information from the Port Authority in one of the shipping ports.

SHIP CONSTRUCTION

One criterion used to separate ship construction from boat building is that when water-going vessels are of the size that they must be constructed at the water's edge, they are usually referred to as ships. Ships are constructed in a shipyard adjacent to an ocean, lake or gulf; upon completion of construction, the ship is launched into the water. Boats are usually mass produced in an inland factory and then transported by truck or railroad to the water. This paper will discuss occupations in the ship construction industry rather than the boat building industry since boat building is part of the manufacturing cluster.

As in any construction project, ship construction requires the efforts of two groups of people. One group has the major responsibility for designing the ship and ascertaining that it is constructed according to these specifications; the other group does the actual construction or ship fabrication.

Because of the extreme danger inherent in a ship of faulty design or construction, those responsible for ship design and construction must be extremely knowledgeable in marine safety.

Most individuals having a major responsibility for ship design have as a minimum a bachelor's degree in the area of naval architecture. Many naval architects have earned the master's degree, and a few have earned the doctor's degree; however, the doctor's degree certainly is not a requirement for occupational entrance. Among the numerous areas of study in naval architecture are: a) general ocean transportation, b) passenger transportation, c) handling of cargo and cargo transportation, d) communication systems, e) nautical navigation, f) fossil and nuclear power plants, and h) maritime safety.

In 1972, beginning naval architectural engineers having the bachelor's degree received an average annual salary of approximately $11,500. Also, architectural engineers having approximately 20 years of experience with a minimum of a bachelor's degree often earned from $17,500 to $22,000 annually.

In addition to those occupations of major responsibility requiring a college degree, there are many opportunities for individuals having a two-year post-high school certificate in technical education. This group of employees works under the supervision of engineers. Many are employed in drafting and illustrating. Graduates of the two-year post-high school institutions often begin employment earning from $6,500 to $8,000 annually.

Because ship construction is largely metal fabrication, highly skilled tradesmen are employed to perform the fabrication operations. Pieces of metal, (e.g., plates, beams, rods, pipes, and valves), must be shaped, formed, and joined during ship construction. Typical trade specialities in ship construction include flame cutters, welders, pipefitters, pipecoverers, electricians, joiners, sheet metal workers, machinists, carpenters and painters. Every journeyman tradesman must be highly skilled in his trade. Each journeyman becomes proficient by progressing through an apprenticeship program after completion of high school. These tradesmen usually work out-of-doors since ships are constructed outside. As the ship nears completion, considerable work is performed inside the ship. These skilled journeymen usually receive from $6.00 to $11.00 per hour, depending on the trade and shipyard location.

MERCHANT MARINE ACTIVITIES

The U.S. Merchant Marine is responsible for activities aboard ships which transport cargo and passengers from port to port in the United States and foreign countries. For management and historical reasons, each occupation aboard ship is grouped within one of three departments: a) the deck department, b) the engine department, and c) the steward's department. The deck department performs the loading, securing, and unloading activities aboard ship, the hull inspection (especially inspections during transit), the ship maintenance during

sailing, and the navigation. The engine department operates and maintains the power plant which both propels the ship and provides electrical current. The steward's department prepares and serves the food, maintains the galleys and dining rooms, and maintains the living quarters for both crew and passengers.

Each ship carries both licensed officers and unlicensed seamen. Approximately one-quarter of the ship's crew are officers.

Aboard each ship is one captain (or master). The captain carries full responsibility for the ship while it is at sea; he also carries extensive responsibility for the ship while it is in port, especially in a foreign port.

The licensed officers in the deck department often include a chief mate, a radio operator, a second mate, and several third mates. The chief mate assists the ship captain in making sure that all of the deck duties are properly executed. The radio operator is responsible for transmitting and receiving messages and maintaining the radio equipment. The second mate is responsible for the ship's navigation and the navigation equipment. The duties of the third mates are quite varied depending on whether the ship is in port or at sea; one of their duties is that of keeping the bridge in proper maintenance.

The unlicensed seamen in the deck department include a boatswain, deck utilitymen, able seamen, and ordinary seamen. The boatswain is the highest ranking unlicensed seaman in the deck department; he is foreman of the unlicensed deck crew. The deck utilitymen perform all deck duties including general maintenance activities and assist in the receiving, securing, and discharging of cargo. The able seamen perform a variety of duties including securing cargo; handling the cables and anchors during docking, departing or anchoring; and doing major maintenance during emergency conditions. The ordinary seamen perform general activities including deck scrubbing, paint chipping, painting, and material handling.

The licensed officers in the engine department usually include a chief engineer, a first assistant engineer, a second assistant engineer and several third assistant engineers. The chief engineer has the responsibility of maintaining all the power plant equipment so that it operates at maximum efficiency. The first assistant engineer directs such activities as power plant output, engine speeds and periodic engine room maintenance. The second assistant engineer is responsible for proper operation and maintenance of the boilers and steam transmittal system. The third assistant engineers are responsible for the operation and maintenance of the electrical, heating, refrigeration, and lubrication systems.

The unlicensed crew in the engine department usually includes an electrician, an engine utility man, several oilers, several fireman-water tenders, and at least one wiper. The electrician maintains the electrical equipment. The engine utility man maintains equipment such as the refrigeration, heating, and pressure and vacuum creating machinery. The oilers keep the equipment properly lubricated. The firemen-water tenders do maintenance work and constantly watch for improperly functioning equipment. The wipers keep the equipment clean.

There are no licensed officers in the steward's department. The unlicensed seamen in the steward's department include a chief steward, a chief cook, a baker, utility personnel and messmen. The chief steward is charged with providing food and living accommodations for all personnel--crew and passengers--aboard the ship; he supervises the food preparation, food serving, recreation and sleeping accommodations. The chief cook and baker are responsible for preparing the food. The utilitymen perform numerous duties including supplying clean linens and towels for those aboard ship, and cleaning the recreation and sleeping accommodations. The messmen assist with food preparation and food serving. They also wash the cooking, baking, and serving ware.

While the size of the ship's crew is related to the size of the ship and the number of sailing days between ports, the number of personnel in the steward's department is also determined by whether the ship is strictly a passenger ship, a combination passenger-cargo ship, or a cargo ship.

To become a licensed merchant marine officer in the U.S. Fleet, the candidate must pass a written examination which is administered by the U.S. Coast Guard. Most individuals who plan to become officers either attend the U.S. Merchant Marine Academy or a state merchant marine academy. The work of a licensed merchant marine is challenging, interesting, and not difficult physically. It might require long sea voyages and occasionally working on the uncovered top deck of the ship where it might be hot, cold, windy, raining or snowing.

Many unlicensed merchant marine seamen have had previous training and experience in the U.S. Navy or U.S. Coast Guard. Prior to each individual's employment as an unlicensed seaman, he must have applied for and received from the U.S. Coast Guard the necessary papers permitting him to be a seaman. After receiving these papers, the individual makes application at one of the union hiring halls in the shipping ports around the country. An unlicensed seaman often receives from $8,000 to $15,000 per year depending on his years of experience, his job, amount of overtime work, and the number of days he works per year.

Anyone contemplating a career in the merchant marines, either as a licensed officer or an unlicensed seaman, should make a serious investigation of the future employment opportunities. Since shortly after World War II, employment in the U.S. Merchant Marines has been declining. This decline appears to be the result of two simultaneously occurring events: a) modern ships require less manpower, and b) the high wages and salaries earned by the U.S. officers and seamen exceed those earned by men of foreign countries, resulting in more and more cargo being transported on ships employing men from other countries.

TUGBOATING

Tugboating includes barge transportation, towing log rafts, assisting ships into and out of berths, moving salvaging equipment, and moving waterfront equipment such as pile drivers,

pontoons and dredges. Tugboats (towboats) are small water going vessels having extremely powerful engines capable of pushing or pulling ships, barges and rafts through the water. Tugboats assist ships into and out of harbors, straits, canals, and estuaries. Tugboats are used whenever it is difficult or dangerous for ships to manuever within a limited area, such as a berth or strait. Occupations in tugboating include tugboat captain, tugboat mate, and bargeman. The tugboat captain is responsible for the tugboat and directs all activities aboard the tugboat. The captain must have a thorough understanding of wind and water currents, water depths, tides, and reefs. He must be able to navigate using such aids as a compass, sextant, buoys and a lighthouse. He might be required to operate radio transmitting and receiving equipment. He must understand water safety and be able to perform under conditions of extreme danger, e.g., storms, typhoons, and fires aboard ship, and on piers. Depending upon the activities of the towboat, the captain might be required to hold a U.S. Coast Guard license.

The tugboat mate works under the supervision of the tugboat captain. The tugboat mate coordinates the activities of the crew members aboard the tug. He must have a thorough knowledge of the rigging required to secure ships and barges to the tug. He must be able to direct water pumping activities. Should it be necessary, the tugboat mate must be capable of assuming the duties of the tugboat captain. As with the tugboat captain, the tugboat mate might be required to hold a U.S. Coast Guard license.

Bargemen (also called deckmen) work under the direction of the tugboat mate. Bargemen work with rigging, since they must secure ships and barges to the tug as well as release them from the tug. They also operate water pumping equipment. When tugs are used in dredging operations, harbor construction and maintenance, and in salvaging operations, bargemen perform those duties aboard the tug which are required to complete these operations.

Personnel engaged in tugboating must be willing to work out-of-doors in all kinds of weather and perform under extremely dangerous conditions. The crew size aboard the tug depends on the size of the tug and the operation that it is performing. Those interested in further information on careers in tugboating should contact the Port Authority at one of the shipping ports or the U.S. Coast Guard.

LONGSHORING

Longshoremen are men who work along the shore loading and unloading ships. Years ago longshoremen did extensive amounts of manual labor, however, the loading and unloading of ships is now becoming more mechanized. All cargo was carried from the shore onto the ship on the backs of men. At the end of the voyage, men again lifted the cargo onto their backs and carried it to shore.

Today, nearly all cargo and fluids are mechanically transported from shore to ship and again from ship to shore. As a result, many longshoremen have become operators of equipment

such as conveyors, winches, tow trucks, cranes, and lift trucks. Typical examples of longshoring activities include operating a crane to load and unload farm tractors, operating a fork lift truck to load crates of automobile parts, positioning the conveyor and then operating the conveyor to load grain onto the ship, driving a tow truck to pull loads of crates from a storage warehouse to the side of the ship, and attaching ropes or cables to crates so the crane operator can move the load aboard the ship.

After a number of years of longshoring labor, some longshoremen advance to the position of foreman. Foremen direct the loading and unloading activities of other longshoremen.

Today it is advantageous for a beginning longshoreman to have a high school education and to be able to operate mechanical loading and unloading equipment. Longshoremen must be willing to work out-of-doors in all kinds of weather. Because of continuing mechanization, fewer men are needed to load and unload ships. The student considering longshoring as a career should seriously investigate the long-range manpower requirements in longshoring.

FISHING AND FISH FARMING

Employment opportunities in the fishing industry include opportunities in two occupational areas: a) the fish farming industry, and b) the catching and processing of fish.

At the present time, most fish farms are located in the southern part of the United States and employ only two or three people. Fish farmers breed fish to be sold as young fish (usually to governmental agencies for stocking lakes and rivers) or raise them until they are of proper size for human consumption. Various governmental agencies also operate fish breeding farms for stocking lakes and rivers. Employees on fish farms perform manual labor, such as taking eggs from the female fish, fertilizing the eggs with milt, and tending the fertilized eggs. After the fish hatch, they are moved to a pond where they grow. If the fish are to be sold for stocking lakes and rivers, they usually are sold and transferred as soon as they can be safely transported. If the fish are to be raised for food, the farmer feeds and tends them until they are of proper size for selling as commercial fish. Skills required by most employees on fish farms are limited with the exception of fish tending skills, which are acquired while working in the occupation.

Even though the number of fish farms is increasing, the majority of occupations in the fishing industry involve going out into the deep waters--the Pacific and Atlantic Oceans, and the Gulf of Mexico--to catch and process fish. The methods used to catch fish vary somewhat according to whether it is being done on the Pacific Coast, in the Gulf of Mexico, or on the Atlantic Coast. For example: on the Pacific Coast, bottom fish are caught in trawls or nets; tuna are caught with tuna "jugs" (lures) towed on the top of the water; salmon are caught with trolled lures; halibut are fished with "long lines" of multiple baited hooks resting on the ocean bottom; and gillnet fishing for salmon in Puget Sound is done with nets.

Some fish processing is done at sea. Depending on the type of fish and location of the fishing operation, employees might remove fish heads, fins, scales and entrails. A fishing fleet might include several smaller fishing boats (ships) and one large processing ship. Most occupations in the catching and processing activities require only limited skills and often are learned on the job.

PETROLEUM AND NATURAL GAS EXPLORATION AND EXTRACTION

Offshore drilling for petroleum and natural gas is becoming more challenging each year because the new wells are being drilled farther and farther from shore and in deeper water. To obtain petroleum and natural gas, a site must be located, a well drilled, and a pipe line laid to the shore before the petroleum and natural gas can be transported.

Over the past 100 years, the exploration for petroleum and natural gas has become an extremely complex science. A petroleum geologist or a petroleum engineer usually heads a small group of men who conduct thorough surveys of the water depths, ocean floor, and subsurface terrain. They collect and analyze soil and rocks to calculate the probability of a petroleum or natural gas field being beneath the water and the probable depth of the field. The petroleum geologist or petroleum engineer has a bachelor's degree as a minimum qualification, and often he has earned the master's degree and occasionally the doctorate. Other geologists and engineers assist the petroleum geologist or petroleum engineer. Newly graduated engineers or graduates of two-year technical institutes draw maps, analyze rocks and soil, and record data.

Prior to drilling a well, a drilling rig, which sets on the ocean floor and extends above the water surface, must be installed. Installation of the drilling rig requires the efforts of petroleum engineers, underwater welders, divers, and other laborers. The actual well drilling operation requires engineers, well-drill operators, well-logging operators, mud-analysis operators and a number of assistants. The pipe laying operation requires the efforts of engineers, technicians, welders, divers, and helpers.

Because of the scientific approach to petroleum and natural gas extraction, persons having specifically studied in the area of petroleum engineering are required. The expertise of tradesmen, especially in the welding trade, is required during the setting of the well drilling rig, the drilling of the well and the laying of the pipe.

Because the offshore oil fields often are many miles from shore, these employees usually live on the water for periods of time up to several months. During these periods of time on the water, the men might work twelve hours a day, seven days a week for several months. Then they return to shore for varying lengths of time. Much of the working time is spent out-of-doors.

Students interested in becoming petroleum engineers or petroleum geologists should contact the major universities, especially along the West Coast and the Gulf of Mexico, to further investigate the opportunities in offshore petroleum and natural gas exploration and extraction. Students who are interested in careers requiring the two-year post-high school certificate should contact two-year institutions which most often are also located along the West Coast and the Gulf of Mexico.

RESEARCH

A very promising area for careers in the marine science cluster is research. While people throughout the world have used the waters for transportation routes and as a supplier of fish for past centuries, only during the last few years have we begun to think seriously of applying our scientific knowledge and techniques to discover the potential of the oceans and lakes. Because of the world's continuing population increase, scientists are wondering to what extent the oceans and lakes might be used to produce food. Certainly fish could be bred and raised more extensively than they now are. But to what extent can crops such as various edible sea weeds or other grains be cultivated in the water? The student who is thinking of a research career in marine foods should consider areas of college study such as marine biology, marine botany, marine microbiology, and marine zoology. The doctorate is often required for research, although some jobs are available for persons holding the master's degree. Also, those who possess the bachelor's degree or even the two-year post-high school technician's certificate can work as research aides or technicians.

Another area in which research opportunities exist is the area of transportation. Researchers in this area tend to concentrate on designing vessels which can travel under, on, or above the water's surface. Researchers are concerned with reducing transportation costs, and increasing the speed and safety of vessels. The researchers in this area usually have doctorates in engineering or physics.

Another area of research opportunities is in petroleum and natural gas exploration and extraction. Researchers in exploration and extraction conduct scientific experiments to develop new methods, technology and equipment which lead to more effective and efficient exploration and extraction processes. Most researchers in this area have earned the doctorate in an area such as petroleum engineering or petroleum geology.

To design and conduct experiments, it usually is necessary that the individual possess a doctorate. Much of the pure research is being supported by the federal government although some is being supported by private corporations. Usually the researcher is employed by either a major university which emphasizes some area of marine science or he is employed by the federal government. At present the average income for researchers possessing the doctorate in an area of marine science is approximately $20,000 per year. A few researchers possess the master's degree as their highest degree although the doctorate is usually a prerequisite.

The researchers usually have assistants, and it is possible to become an assistant with a master's degree or occasionally with a bachelor's degree. As the employee has less formal education, his salary decreases accordingly. Also, some technicians having earned the two-year post-high school technician's certificate are employed as aides and technicians. These aides and technicians observe and maintain the equipment as well as record data under the direction of the researcher. Beginning technicians often earn from $6,000 to $8,000 per year.

SOURCES OF ADDITIONAL INFORMATION

The student who desires additional information about occupations in the marine science cluster should obtain a copy of the most recent publication of *Occupational Outlook Handbook* (U.S. Department of Labor, Bureau of Labor Statistics). This handbook, which contains nearly 900 pages, provides job descriptions, education and training requirements, working conditions, and yearly earnings. It also provides names and addresses where students can obtain additional up-to-date occupational information. For example, if they should desire information on occupations in the merchant marines, one of the addresses provided is "Office of Maritime Manpower, Maritime Administration, U.S. Department of Commerce, Washington, D.C. 20235" (U.S. Department of Labor, Bureau of Labor Statistics, p. 747). If the student desires additional information on opportunities in oceanography, the handbook provides seven addresses for this additional information; one of these addresses is "Marine Sciences Affairs Staff, Building 159 East, Room 476, Washington Navy Yard, Washington, D.C. 20390" (pp. 160-161).

Another source of information is the *Dictionary of Occupational Titles* (DOT). The DOT is a two volume publication with supplements, which provides job descriptions and some information on working conditions and education and training requirements. For example, on page 432, Volume I of the DOT, a job description of longshoremen is found.

SUMMARY

In this paper, the occupations within the marine science cluster have been grouped into eight categories:

1. Harbor Construction and Maintenance. Included in this grouping are all those jobs which occur during the construction and maintenance of a harbor. This includes marine engineers, surveyors, draftsmen, electricians, carpenters, and general laborers.

2. Ship Construction. Included in this grouping are all those jobs which occur as the result of ship construction. This includes naval architects, fossil and nuclear power plant engineers, electronics engineers, draftsmen, flamecutters, welders, machinists, carpenters, and painters.

3. Merchant Marine Activities. These occupations include licensed merchant marine officers (ship's captain, radio operators, mates, and engineers) and unlicensed merchant marine seamen (utility men, able-bodied seamen, ordinary seamen, electricians, firemen, wipers, stewards, cooks, bakers, and messmen).

4. Tugboating. Tugboats (towboats) are used to move ships in and out of limited areas such as a berth or canal. They also move barges and log rafts. Occupations include tugboat captain, tugboat mate, and bargeman.

5. Longshoring. Longshoremen work along the shore loading and unloading ships. Today, most material handling is accomplished by mechanical means. Thus much of the longshoring work involves operating equipment such as grain conveyors, cranes, hoists, lift trucks, and tow trucks. In addition to operating the equipment listed above, longshoremen also secure the cargo by cable and ropes to cranes or hoists, secure cargo in a hold, and transfer cargo from one hold to another.

6. Fishing and Fish Farming. Numerous owner-operated fish farms are appearing in the southern states. Here the farmer almost always has a fish hatchery. He either sells the fish as stock fish or raises them to sufficient size to be processed and consumed as human food. At the present time, however, most jobs in the fishing industry involve employment on fishing vessels. Fish are caught in large nets and often processed while the vessel is still at sea.

7. Petroleum and Natural Gas Exploration and Extraction. Exploration for and extraction of petroleum and natural gas is becoming a highly scientific operation. The petroleum or gas field must be located, a well drilled, a pipeline laid and the fuel transported from the well to the shore. To perform these tasks, many individuals having various skills are required, including petroleum engineers, geologists, technicians, well-drill operators, mud-analysis operators, technicians, and helpers.

8. Research Activities. Because the population of the world is continually increasing, and the supply of resources is decreasing, considerable research will be undertaken to determine the potential of the marine areas to produce food and increase petroleum and natural gas exploration and extraction. Considerable research also will be undertaken in the area of water transportation. Many of the research positions will require people having earned the doctorate. Although supporting occupations will be filled by people having master's or bachelor's degrees, some positions will be filled by technicians holding the two-year post-high school certificate.

The student who is interested in a career in the marine science cluster is encouraged to seek additional information including (a) immediate and future employment opportunities, (b) geographical location of employment opportunities, (c) education/training requirements, (d) working conditions, and (e) monthly/yearly earnings.

ANNOTATED BIBLIOGRAPHY[1]

Abel, Robert B. *Education in Marine Science and Technology--Historical and Current Issues.* Presented to the American Association for the Advancement of Science, December 27, 1967. December 27, 1967. 21 pp. ED 056 859 MF $0.65 HC $3.29.

Areas covered in this review of marine science and technology include oceanography education history, training of technicians, the ocean engineer, manpower supply and demand, oceanography and the social sciences, students' problems, and school survey problems.

American Society for Oceanography. *The Oceans and You.* Washington, DC: American Society for Oceanography. 1971. 45 pp. ED 064 088, document not available from EDRS. Available from ASO Information Kit, 1730 M Street N.W., Suite 412, Washington, D.C. 20036 ($3.00).

Seven booklets are included in the Oceanographic Information Kit. They provide the following information: a general overview of the nature of oceanography and the study necessary in preparing for a career in this field; possible oceanographic employment opportunities with the federal government as described by the different government agencies involved in marine activities; descriptions of employment possibilities in private industries along with a reference to three directories which list other industries in the field; university employment; a reading list (nearly 300 entries) which is grouped into elementary reading level (K-9), secondary (10-12 and lower college) and adult level which contains technical books; a list, current through fall 1971, of programs, degree(s) offered and offices to contact at various colleges offering oceanography curricula; and a list of other information sources. The Booklets vary from four to fourteen pages.

Chan, Gordon L. *The Education and Training of Marine Technicians.* Washington, DC: American Association of Junior Colleges. 1968. 53 pp. ED 025 238 MF $0.65 HC $3.29.

---

[1]Bibliographical entries followed by an ED number are generally available in hard copy or microfiche through the Educational Resources Information Center (ERIC). This availability is indicated by the abbreviations MF for microfiche and HC for hard copy. Order from ERIC Document Reproduction Service (EDRS), P.O. Drawer O, Bethesda, Maryland 20014. Payment must accompany orders totaling less than $10.00. Doctoral dissertations with a microfilm number are available in microfilm ($4.00) or xerographic copy ($10.00) from University Microfilms, Dissertation Copies, Post Office Box 1764, Ann Arbor, Michigan 48106.

A study of the need for marine technicians in California, information from a national conference held in Florida in 1968, and national implications are included in this report. This document discusses the following areas: definition and classification of marine technologists; demand for marine technologists; type of work and skills and training needed; pay scale; how marine technologists are educated and which junior colleges are providing the training; the role of women as marine technologists; amount of financial support and evaluation programs that are needed. General points and recommendations are made.

Commission on Marine Science, Engineering and Resources. *Industry and Technology: Keys to Oceanic Development, Volume 2, Panel Reports on Marine Science, Engineering and Resources.* Washington, DC: Commission on Marine Science, Engineering and Resources. 1969. 319 pp. ED 056 854 MF $0.65 HC $13.16. Also available from the Government Printing Office (Cat. No. PR 36.8:M 33/Pv.1-3, $10.25, sold in sets of 3 volumes only).

This document, the second of a three-volume series of panel report assembled by the Commission on Marine Science, Engineering and Resources, contains part V (Report of the Panel on Industry and Private Investment) and part VI (Report of the Panel on Marine Engineering and Technology). Part V contains major recommendations relating to consolidation of federal functions, multipurpose technology, and attracting entrepreneurial investment. An assessment of the present national effort in marine engineering and technology is included in part VI.

Gillie, Angelo C., and Pratt, Arden L. *Marine Technology Programs: Where We Are and Where We're Going.* Washington, DC: American Association of Junior Colleges. 1971. 55 pp. ED 062 111, document not available from EDRS. Available from American Association of Junior Colleges, 1 Dupont Circle, N.W., Washington, D.C. 20036 ($3.00).

Presentations and discussion at the 1970 Conference on Training of Marine Technologists in the Junior Colleges are synthesized and summarized in this document. Translating valid manpower predictions into meaningful program development, making successful programs possible by involvement between potential employers and educators, aspects of curriculum development, facilities and equipment needed, and problems of recruiting and retaining students and personnel in the marine science field are discussed. A list and description of 21 institutions' programs is provided in the Appendix in addition to the participants at the conference and a list of over 90 marine technician positions.

Gordon, Kennith Glenn. *A Taxonomy of Marine Technicians and Technologists and the Implications for Training Them.* Tallahassee: Edward Ball Marine Lab, Florida State University. June, 1971. 239 pp. ED 062 509, document not available from EDRS. Available from National Technical Information Service, Springfield, Virginia 22151 (PB 199 665, MF $0.65; see catalog for hard copy price).

The purpose of this three-phase study was to: determine the basic education, training, and classification characteristics necessary for marine technicians and technologists; suggest their implications to labor administrators, educators, and oceanographers; and develop a method for classifying these personnel. Varied methodologies were employed to obtain information, along with statistical tests.

National Council on Marine Resources and Engineering Development. *University Curricula in the Marine Sciences and Related Fields, Academic Years 1969-70 and 1970-71.* Washington, DC: National Council on Marine Resources and Engineering Development. 1969. 273 pp. ED 041 745 MF $0.65 HC not available from EDRS. Available from the Government Printing Office (0-363-212, $2.00).

Questionnaires sent by the Committee on Marine Research, Education and Facilities provided the basis for information included in this document on marine science institutions, academic degrees, curricula, teaching and research facilities and teaching faculties. Programs are divided into five major categories: Marine Science, Ocean Engineering, Maritime Officers, Fisheries, and Marine Technician. Programs involving fifteen or more semester hours are included in the first section, and institutions offering shorter courses are listed in an appendix.

_____. *University Curricula in the Marine Sciences and Related Fields. Academic Years 1971-72 and 1972-73.* Washington, DC: Naval Oceanographic Office. August, 1971. 214 pp. ED 063 861, MF $0.65 HC $9.87. Also available from the Government Printing Office (0842-0053; $1.75).

Information concerning marine sciences institutions, academic degrees, curricula, teaching and research facilities, and teaching faculties at 134 academic institutions throughout the country was compiled for this document. General information on admission requirements for graduate work and financial assistance is included. Curricula in marine sciences and related fields is included. Institutions are presented by geographic location in an appendix.

Sprintzer, Allan D. *Trade Union Sponsored Occupational Training in the U.S. Maritime Industry: The Upgrading and Retraining Program of the National Maritime Union.* Final Report. Ithaca: State University of New York, School of Industrial and Labor Relations, Cornell University. June, 1971. 355 pp. ED 056 277, document not available from EDRS. Available from National Technical Information Service, Springfield, Virginia 22151 (PB-201 126 MF $0.65, HC $6.00).

This study examines objectives, structures, functions, and results of an effort to upgrade and retrain personnel in the National Maritime Union during the 19 months from May, 1966 to December, 1967. This document evaluates the results of this program and attempts to determine their factors.

U.S. Department of Labor. *Dictionary of Occupational Titles, 1965.* Third Edition. Volume I, Definitions of Titles. Washington, DC: Bureau of Employment Security, U.S. Department of Labor. 1965. ED 013 963, document not available from EDRS. Available from the Superintendent of Documents, the Government Printing Office, Washington, D.C. 20402 (L7.2--OC1/965/V. I, $5.00).

The *Dictionary of Occupational Titles* (DOT) is a two volume publication, with supplements, which provides job descriptions and some information on working conditions, and education and training requirements. For example, on page 432, Volume I of the DOT, a job description of longshoremen is found.

_____. *Dictionary of Occupational Titles, 1965.* Third Edition. Volume II, Occupational Classification and Industry Index. Washington, DC: Bureau of Employment Security, U.S. Department of Labor. 1965. ED 013 964, document not available from EDRS. Available from the Superintendent of Documents, the Government Printing Office, Washington, D.C. 20402 (L7.2--OC1/965/V. II, $4.25).

_____. *Occupational Outlook Handbook.* 1972-73 Edition. Washington, DC: Bureau of Labor Statistics, U.S. Department of Labor. 1972. 885 pp. ED 063 469 MF $0.65 HC $29.61. Also available from the Superintendent of Documents, the Government Printing Office, Washington, D.C. 20402 (L23:1700, $6.25).

This handbook, published annually, provides job descriptions, education and training requirements, working conditions, yearly earnings, and employment outlooks for many occupations. It also provides addresses where additional up-to-date occupational information can be obtained.

FILMED FROM BEST AVAILABLE COPY

The mission of the ERIC CLEARINGHOUSE ON VOCATIONAL AND TECHNICAL EDUCATION is to acquire, process, and disseminate research and related information and instructional materials on vocational and technical education and related fields. It is linked to the Educational Resources Information Center (ERIC), the national information system for education.

PRODUCTS

The information in the ERIC system is made available to users through several information access products. Documents and journal articles are acquired, selected, abstracted, indexed, and prepared for announcement in these publications. The document's abstract can be read in the same ERIC publication in which it is indexed. The full text of announced documents is available from the original source or from the ERIC Document Reproduction Service (EDRS) in microfiche and hard copy form.

- ABSTRACTS OF INSTRUCTIONAL MATERIALS IN VOCATIONAL AND TECHNICAL EDUCATION (AIM), a quarterly publication, provides indexes to and abstracts of a variety of instructional materials intended primarily for teacher or student use.
- ABSTRACTS OF RESEARCH MATERIALS IN VOCATIONAL AND TECHNICAL EDUCATION (ARM) is published quarterly and provides indexes to and abstracts of research and related materials.
- COMPUTER TAPES of AIM and ARM contain resumes of over 6,000 documents on vocational and technical education that have not appeared in RIE.
- RESEARCH IN EDUCATION (RIE) and CURRENT INDEX TO JOURNALS IN EDUCATION (CIJE) are monthly publications. Many of the documents announced in AIM and ARM are also listed in RIE, the Central ERIC publication. Journal articles reviewed by the Clearinghouse are announced in CIJE, the CCM Corporation publication.

CAREER EDUCATION

A new project, the Supportive Information for the Comprehensive Career Education Model (SI/CCEM), is using the ERIC document base to provide information for the development of the Comprehensive Career Education Model (CCEM). In addition to using ERIC, the project staff is helping to acquire additional materials for CCEM. Many of these are being announced in AIM, ARM, and RIE.

INFORMATION ANALYSIS

The Clearinghouse engages in extensive information analysis activities designed to review, analyze, synthesize, and interpret the literature on topics of critical importance to vocational and technical education. Review and synthesis papers have been prepared on many problems or processes of interest to the entire field. Current emphasis is upon interpretation of major concepts in the literature for specific audiences. Recent career education publications have been developed that clarify and synthesize for program developers and decision-makers the theoretical, philosophical, and historical bases for career education.

USER SERVICES

In order to provide information on ways of utilizing effectively the ERIC document base, the Clearinghouse provides the following user services:

1. Information on the location of ERIC microfiche collections;
2. Information on how to order ERIC access products (AIM, ARM, RIE, and CIJE);
3. Bibliographies on timely vocational-technical and related topics such as (1) career education, (2) vocational education leadership development, (3) vocational education for disadvantaged groups, (4) correctional institutions, (5) cooperative vocational education, (6) information system for vocational decisions, and (7) management systems in vocational education;
4. Brochures describing ERIC operations and products;
5. Directing users to sources of information required for solving specific problems; and
6. Referral of requests to agencies that can provide special services.

YOUR INPUTS

Your comments, suggestions, and questions are always welcomed at the Clearinghouse. In addition, any documents you feel are beneficial to educators may be sent to the Clearinghouse for possible selection and inclusion into AIM, ARM, or RIE.

ERIC Clearinghouse on Vocational and Technical Education
1960 Kenny Road
Columbus, Ohio 43210

FILMED FROM BEST AVAILABLE COPY

VT 020 373

DESCRIPTORS - Career Education; *Occupational Clusters; *Ocean Engineering; Oceanology; Marine Biology; *Marine Technicians; *Seamen; Construction (Process); Fisheries; Fuels; Water Resources; *Career Opportunities; Occupational Information; Educational Needs.

ABSTRACT - This paper discusses career opportunities in eight broad groups of marine science occupations: harbor construction and maintenance, ship construction, merchant marine activities, tugboating, longshoring, fishing and fish farming, petroleum and natural gas exploration and extraction, and research activities. The marine science cluster is defined to include those occupations which are directly related to activities occurring because of the presence of large bodies of water. Each of the groups described contains occupations with education and training requirements ranging from those calling for very limited skills to those requiring doctoral degrees. An annotated bibliography provides additional sources of information for marine science occupations. (MF)